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(54) ASSOCIATION MEMORY MODULE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an association memory
module having a high speed property being produced by performing
best matching processing using hardware, and the flexibility for using
the capacity of the entire prepared association memory module
effectively.

SOLUTION: The memory module 100 has a means capable of
arbitrarily setting the order of priority of data selection in a priority
encoder 106 from the outside, and a simultaneous retrieval execution
means for simultaneously giving input data to each of a plurality of
association memories 100a-100d and for allowing each of a plurality of
association memories 100a-100d to simultaneously execute retrieval.
Then, the priority encoder 106 selects one retrieval result from a
plurality of retrieval results being obtained by simultaneously executing
the retrieval.
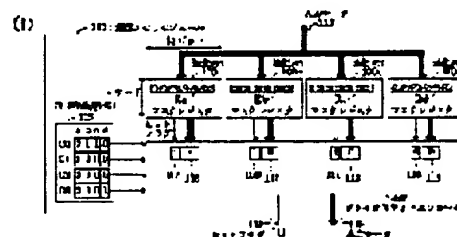
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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the circuit diagram showing the associative memory module 100 which is one example of this invention.
[Drawing 2] It is the circuit diagram showing the associative memory module group 200 which are other examples of this invention, and is drawing showing the circuit arrangement which perform large-scale best match processing.
[Description of Notations]
100 -- Associative memory module,
100a, 100b, 100c, 100d -- Associative memory,
Ra, Rb, Rc, Rd -- Mask register,
106 -- Priority encoder,
115 -- Register for group registration,
117 -- Input data,
118 -- Output data,
200 -- Associative memory module group,
200a, 200b, 200c -- Associative memory module,
211 -- Priority encoder,
215 -- Register for group registration,
213 -- Semiconductor memory,
217 -- Input data,
214 -- Output data.

[Translation done.]

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DRAWINGS

[Drawing 1]

(1)
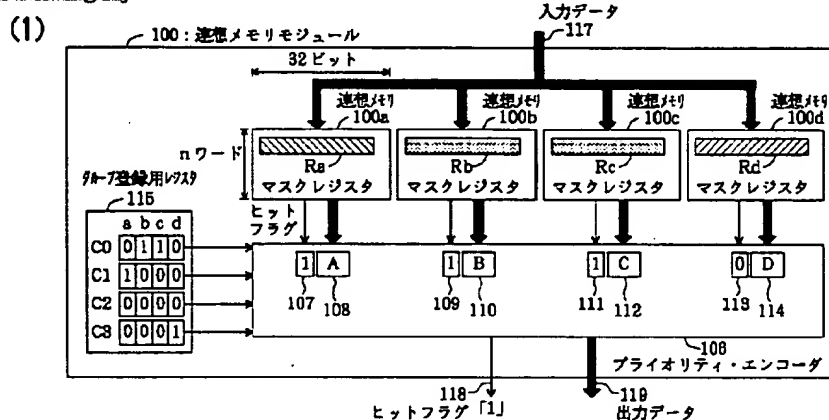
(2) 各マスクレジスタに格納されているマスクデータの値
マスクレジスタ Ra = 11111111 11111111 00000000 00000000
マスクレジスタ Rb = 11111111 11111111 11111111 00000000
マスクレジスタ Rc = 11111111 11111111 11111111 00000000
マスクレジスタ Rd = 11111111 00000000 00000000 00000000

K4210

[Drawing 2]

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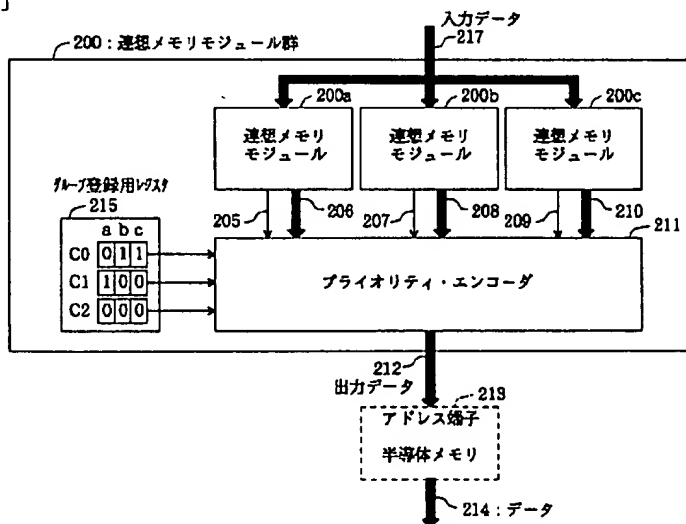3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] Out of the data table which consists of two or more data constellations beforehand stored in the data-storage means which this invention makes a search key the bit string of a part of input data, and is built in the associative memory module When the data constellation containing the item which is in agreement with the above-mentioned search key is searched, it has the function which reads the content or a store position and the above-mentioned search key is moreover simultaneously [with two or more data constellations] in agreement The bit string of a search key is related with the associative memory module which takes out the data constellation which is in agreement with the longest thing.
[0002]
[Description of the Prior Art] In order to perform IP routing processing using the IP routing processor (router) with two or more input/output port, it is necessary to determine the output port which should deliver the packet which needed to detect the 32-bit "partner IP address", and needed to send out the packet which carried out [above-mentioned] arrival to the output port which suits this detected partner IP address, that is, arrived from the header information of the packet which reached input port. In this case, the above "a partner IP address" is made into a search key, the item in the routing table which exists in a router is searched, and the output port which should deliver the packet which carried out [above-mentioned] arrival is determined by choosing the output port registered into the above-mentioned item which was in agreement with the above-mentioned search key.
[0003] The best match method is adopted as processing which determines this output port. This best match processing is one for one correspondence for every IP address of the about the IP address in routing table first. After performing mask processing excepted from the object of a matching of the bit of a part of "partner IP address" using the network mask information currently prepared separately, this data by which mask processing was carried out is made into a search key. When comparison processing is carried out with searched data and two or more candidates are matched, it is processing which adopts the data (data with the shortest bit width of face excepted from the matching object) with the longest length (bit width of face of a mask) of a mask as a candidate of the highest priority.
[0004] On a mask data, when [the bit which stands as for "1"] it is a comparison object (for example, when a search key matches the data (data whose comparison contrast is 24 bits) of the 32 bit width of face whose mask data is "11111111 11111111 11111111 00000000", and the data (data whose comparison contrast is 16 bits) of the 32 bit width of face whose mask data is "11111111 11111111 00000000 00000000"), a comparison object chooses the data of the former which is 24 bits.
[0005] Although this best match processing is the main fraction of routing processing, since best match processing is conventionally performed by software using CPU, there is a problem that the enhancement in the own throughput of a router is prevented.
[0006]
[Problem(s) to be Solved by the Invention] On the other hand, the associative memory (CAM) is conventionally known as hardware which compares the content at high speed. This conventional associative memory does not perform mask processing individually for each [which is stored in order that mask processing may be uniformly performed to input data and searching the content may only perform the above-mentioned best match processing] IP address of every. By the way, the mask data used for best match processing can consider that they generally perform the above-mentioned

best match processing on communicative convention to two or more IP addresses, using the conventional associative memory two or more since there are many same things.

[0007] That is, a mask data stores in the same associative memory first the searched data which have the same "partner IP address." In this case, each associative memory sets the mask data of the above-mentioned identity to the mask-data store register which it has, respectively. When actually performing reference processing, first, input data (reference data) is simultaneously given to each associative memory, and mask processing for every associative memory and reference are performed all at once. Next, it sends to the priority encoder which established each reference result separately, and, finally the reference result in which bit width of face has the longest mask data is adopted among two or more reference results which the associative memory outputted. By doing in this way, best match processing is realizable.

[0008] However, since the number of cases of the searched data which should be stored cannot be beforehand assumed when performing best match processing as mentioned above, using the conventional associative memory two or more, when the circuit which performs best match processing is constituted, capacity of the associative memory which should be prepared to each mask data cannot be predicted.

[0009] That is, excess and deficiency arise in capacity and the number of cases of the searched data (partner IP data which should be searched) with the same mask data has the problem that capacity of the prepared whole associative memory may be unable to be used effectively in it, when it is expected that there is variation for every mask data, therefore the associative memory of the same capacity is prepared to each mask data.

[0010] this invention aims at offering the associative memory module which has the rapidity by performing best match processing by hardware, and the flexibility which can use the capacity of the prepared whole associative memory effectively.

[0011]

[Means for Solving the Problem] this invention performs mask processing to input data by the mask data given from the exterior. Two or more associative memories which search the searched data which match the above-mentioned search key from two or more searched data which take out the bit string by which the mask was carried out as a search key, and have been beforehand stored by the above-mentioned mask processing, In the associative memory module which has the priority encoder which selects one reference result out of two or more reference results which each of two or more above-mentioned associative memories outputted according to the priority foreword set up beforehand The priority foreword setting means which can be set up is arbitrarily established for the above-mentioned priority foreword of the data selection in the above-mentioned priority encoder from the exterior. Moreover, the above-mentioned input data is simultaneously given each of two or more above-mentioned associative memories. A simultaneous-search execution means to make each of two or more above-mentioned associative memories perform reference simultaneously is established. the above -- it is the associative memory module as which the above-mentioned priority encoder selects one reference result out of two or more reference results which perform simultaneously and were obtained according to the priority foreword by which a setup was carried out [above-mentioned]

[0012]

[The gestalt and example] of implementation of invention Drawing 1 (1) is a circuit diagram showing the associative memory module 100 which is one example of this invention.

[0013] The associative memory module 100 has four associative memories (CAM) 100a, 100b, 100c, and 100d and the register for group registration 115.

[0014] Associative memories [100a, 100b, 100c, and 100d] each builds in the circuit which performs mask processing uniformly to input data 117, and builds in the mask registers Ra, Rb, Rc, and Rd which store a mask data, respectively. Here, associative memories 100a, 100b, 100c, and 100d have the capacity of n words, when 32 bits is made into a single word. Moreover, the capacity of each mask registers Ra, Rb, Rc, and Rd is also 32 bits, respectively.

[0015] It corresponds by the one for one, grouping of the searched data which have the same mask data mutually is carried out to one group, searched data and a mask data are each group unit, and searched data are stored in a mutually different associative memory. Moreover, the above-mentioned mask data is set to the mask register built in the associative memory which corresponds, respectively.

[0016] Suppose that the value shown in drawing 1 (2) is stored in each of the mask registers Ra, Rb, Rc, and Rd prepared in associative memories [100a, 100b, 100c, and 100d] each. And if the mask data which mask registers Ra-Rd store is mutually the same, four mask registers will be divided into the three groups "Ra", "Rb, Rc", and "Rd" in the

status which they are collected into one group, therefore shows in drawing 1 (2). In drawing 1 (1), the same pattern is mutually given to the mask register belonging to the same group, and it has displayed on it.

[0017] The associative memory module 100 can store the searched data which have a maximum of four kinds of mask datas, and associative memories 100a-100d output the hit flag which shows that the searched data which were in agreement as a result of reference exist, and the searched data which were in agreement as a result of the above-mentioned reference. A hit flag is set to "0" when the searched data which the hit flag was set to "1" and were in agreement when congruous searched data existed do not exist. And all the signals that associative memories 100a-100d outputted, respectively are inputted into the priority encoder 106.

[0018] When two or more hit flags are set to "1", according to the priority foreword which defines which is finally made an output, from two or more hit flags set to "1", the priority encoder 106 chooses one hit flag, and chooses the searched data corresponding to this selected hit flag. The above-mentioned priority foreword is determined by the value of the register for group registration 115.

[0019] The register for group registration 115 Four associative memories 100a and 100b, It is what shows to which group each (100c and 100d) belongs. It has four registers C0, C1, C2, and C3, registers C0, C1, C2, and C3 consist of 4 bits, respectively, and the above-mentioned 4 bits correspond to associative memories 100a, 100b, 100c, and 100d from the left among drawing 1 , respectively.

[0020] For example, in the example shown in drawing 1 , since a register C0 is "0110" Two associative memories with associative memories 100b and 100c belong to a group C0. The **** memory which associative-memory 100a belongs to a group C1 since a register C1 is "1000", and belongs to a group C2 since a register C2 is "0000" does not exist, but since a register C3 is "0001", 100d of associative memories belongs to a group C3.

[0021] And the same mask data is mutually set to the mask register of the associative memory which each of the associative memory belonging to the same group has the same mask data mutually, that is, belongs to the group of the above-mentioned identity. In this case, in the order of registers C0, C1, C2, and C3, suppose that it is a group with a high priority, and the searched data which have a mask data with long bit width of face in the order are stored in a corresponding associative memory. As the above-mentioned example shows to drawing 1 (2), the priority with associative memories 100b and 100c is the highest, next the priority of associative-memory 100a is high, and the priority of 100d of associative memories is high at the end.

[0022] More nearly here, what is located in left-hand side makes high the priority of the associative memory belonging to the same group among the register for group registration 115 shown in drawing 1 . Therefore, in the above-mentioned example, the priority of associative-memory 100b is higher than the priority of associative-memory 100c.

[0023] The priority encoder 106 can determine the priority about input data as a meaning according to the above-mentioned rule.

[0024] The associative memory module 100 by that is, the mask data given from the exterior Perform mask processing to input data and the bit string in which the mask was carried out by the above-mentioned mask processing is taken out as a search key. From two or more searched data beforehand stored in associative memories 100a-100d Two or more associative memories 100a-100d which search the searched data which match the above-mentioned search key are formed. From two or more reference results which associative memories [two or more / 100a-100d] each outputted According to the priority foreword set up beforehand, it is the associative memory module in which the priority encoder 106 out of which one reference result is selected was formed, and has a priority foreword setting means and a simultaneous-search execution means. Moreover, the above-mentioned priority foreword setting means is a means which can be set up arbitrarily from the exterior about the above-mentioned priority foreword of the data selection in the priority encoder 106, and a simultaneous-search execution means is a means to give the above-mentioned input data simultaneously to associative memories [two or more / 100a-100d] each, and to make associative memories [two or more / 100a-100d] each perform reference simultaneously.

[0025] Next, an operation of the above-mentioned example is explained.

[0026] Input data 117 is simultaneously applied to four associative memories 100a, 100b, 100c, and 100d, the input data is searched with the example shown in drawing 1 , and the searched data which are in agreement with a search key presuppose in it, that it exists in associative memories 100a, 100b, and 100c as a result of this reference. That is, supposing the hit flags 107, 109, 111, and 113 are set to "1", "1", "1", and "0", respectively, the content of a setting of the register for group registration 115 shows that the priority of associative-memory 100b is the highest among the four above-mentioned associative memories 100a, 100b, 100c, and 100d. In the order of registers C0, C1, C2, and C3, a

priority is high, and among the register for group registration 115 shown in drawing 1 , since a priority is high, the priority of associative-memory 100b will be that is, as the highest as what is located in left-hand side.

[0027] Therefore, as an end result, the priority encoder 106 outputs the value 110 of associative-memory 100b as output data 119, sets to "1" further the hit flag 118 which tells the thing of the associative memory module 100 which correspondence data exist collectively, and tells it outside. According to the above-mentioned example, the above-mentioned best match processing is realizable.

[0028] Moreover, according to the above-mentioned example, according to a setup of the register for group registration 115, **** can also carry out the group division of the four associative memories 100a, 100b, 100c, and 100d. For example, there are three modalities of mask, and when the number of cases of each searched data is below n, it can correspond by the associative memory 100a, 100b, and 100c whose number is three, for example, associative memories. Searched data are newly added and namely, the mask data only corresponding to the group (for example, associative-memory 100a) of a predetermined mask data When n affairs which are the number of cases of searched data storable in one associative memory are exceeded, The mask data corresponding to the searched data after n+1 affair is stored in 100d of associative memories (that is,). The same mask data as the mask data currently written in associative-memory 100a is written in the mask register Rd of 100d of associative memories. Furthermore, what is necessary is just to rewrite the value of the corresponding register for group registration 115 in the group to which associative-memory 100a belongs, so that 100d of associative memories may belong.

[0029] Thus, what is necessary is to store the mask data corresponding to the above-mentioned searched data in the associative memory other than the one above-mentioned associative memory, and just to rewrite the value of the corresponding register for group registration 115 in the above-mentioned predetermined group so that the associative memory by the above may belong when the number of the searched data stored in one associative memory belonging to a predetermined group increases. The store field of the new searched data of n affairs can newly be made, without changing entirely the searched data already registered by doing in this way.

[0030] Moreover, in the example shown in drawing 1 , since the number of the registers which constitute the register for group registration 115 was made the same as that of the total (the number of = associative memories) of a group and the bit width of face of each above-mentioned register was set up similarly to the number of associative memories, the total number of bits of the register for group registration 115 becomes the square of the number of an associative memory. For example, in the example shown in drawing 1 , the total number of bits of the register for group registration 115 becomes 4x4=16 bit. Thus, there is a policy taken in order to simplify the logic of a priority encoder. By the way, since what is necessary is just to be able to express to which group each associative memory belongs, the number of the group is encoded and it may be made to express in a binary digit. For example, in the example shown in drawing 1 , if four groups exist, and each group number is set up as shown in "00", "01", "10", and "11", the number of a group can be expressed by 2 bits. If it does in this way, the priority of the searched data in a priority encoder is controllable by 4x2=8 bit.

[0031] Moreover, grouping is not performed but it may be made to control the priority of a priority encoder by giving the order of a meaning to each associative memory. In this case, the total number of bits of a register is the same as that of the case of the above which encodes the number of a group that what is necessary is to make the number of bits which expressed the total of an associative memory with the binary digit correspond for every associative memory, and just to have it. Generally by this, it becomes easy rather than the above-mentioned case the above-mentioned logic of a priority encoder encodes the number of a group. However, when the order of a meaning is given to each associative memory, it will be necessary to shift the priority foreword of every No. 1 of other associative memories forward and backward, and, for this reason, the need of rewriting the value of a register may arise to raise the priority of the more newly than the associative memory already used added associative memory. If the register for group registration 115 is used like the associative memory module 100 compared with this, when adding a new associative memory to the same group which already exists, it is not necessary to change the value of other already set-up registers.

[0032] Drawing 2 is a circuit diagram showing the associative memory module group 200 which are other examples of this invention, and is drawing showing the circuit arrangement which perform large-scale best match processing.

[0033] The associative memory module group 200 has the associative memory modules 200a, 200b, and 200c, the priority encoder 211, and the register for group registration 215.

[0034] The associative memory modules 200a, 200b, and 200c are the associative memory module 100 and the same associative memory module, respectively.

[0035] Each function of the priority encoder 211 and the register for group registration 215 is the same as the function of the priority encoder 106 shown in drawing 1 , and the register for group registration 115.

[0036] The associative memory module group 200 by that is, the mask data separately given from the exterior Perform mask processing to input data and the bit string in which the mask was carried out by the above-mentioned mask processing is taken out as a search key. Two or more associative memories which search the searched data which match the above-mentioned search key from two or more searched data stored beforehand, From two or more reference results which each of two or more above-mentioned associative memories outputted According to the priority foreword set up beforehand, it has the 1st priority encoder which selects one reference result. Arbitrarily the above-mentioned priority foreword of the data selection in the priority encoder of the above 1st from the exterior The 1st priority foreword setting means which can be set up, Two or more associative memory modules which have a simultaneous-search execution means to give the above-mentioned input data simultaneously to each of two or more above-mentioned associative memories, and to make each of two or more above-mentioned associative memories perform reference simultaneously, The 2nd priority encoder which selects one reference result out of two or more reference results outputted from each of two or more above-mentioned associative memory modules according to the priority foreword set up beforehand, It is the associative memory module group which it has arbitrarily the 2nd priority foreword setting means which can be set up from the exterior, and two or more above-mentioned associative memory modules consist of hierarchical in the above-mentioned priority foreword of the data selection in the priority encoder of the above 2nd.

[0037] In the associative memory module group 200, input data (search key) 217 is simultaneously sent to each of the associative memory modules 200a, 200b, and 200c, reference processing is carried out in parallel, and the whole reference result 212 is obtained. Large-scale-ization can be attained easily, without making retrieval time into a sacrifice not much compared with the case where only one associative memory module is used, if the associative memory modules 200a, 200b, and 200c are constituted hierarchical, as shown in drawing 2 (if it being got blocked and two or more associative memory modules 100 being constituted hierarchical). That is, since the associative memory modules 200a, 200b, and 200c in the associative memory module group 200 perform reference processing simultaneously, processing and time of only one associative memory module are the same, and it is only that only the processing time of the priority encoder 211 starts too much.

[0038] According to the associative memory module group 200, the hardware which performs more large-scale mast match processing is easily realizable by using an associative memory module hierarchical.

[0039] Moreover, what is necessary is to consider that the reference result 212 is the address, to add the above-mentioned address to the address terminal of the semiconductor memory 213 prepared outside separately, and just to obtain an end result 214, when there is much amount of data per searched data.

[0040] If it does in this way, the capacity of the associative memory [itself] carried in the associative memory modules 200a, 200b, and 200c is reducible. That is, if the information (informations, such as an information which specifies an output port, and various parameters required for setting of equipment) included in searched data is stored in associative memories 100a-100d Although the number of the part of searched data storable in associative memories 100a-100d decreases The information (informations, such as an information which specifies an output port, and various parameters required for setting of equipment) included in searched data If it stores in the semiconductor memory 213 prepared in the exterior of the associative memory module group 200 and it is made to output an end result 214 from semiconductor memory 213, without storing in associative memories 100a-100d The capacity of one searched data stored in the associative memory carried in the associative memory modules 200a, 200b, and 200c itself is reducible.

[0041] That is, to store two or more searched data and what is necessary is just made to have external memory which considers that the output signal of the associative memory module group 200 is the address, and outputs the above-mentioned searched data according to the above-mentioned address as an end result among two or more searched data by which the store was carried out [above-mentioned].

[0042] Moreover, in the associative memory module group 200, since the register for group registration 215 is used, when adding a new associative memory to the same group which already exists, it is not necessary to change the value of other already set-up registers.

[0043] Moreover, each above-mentioned example is suitable for the intended use which performs best match processing used by routing processing for Internet Protocol (IP) etc. at high speed.

[0044]

[Effect of the Invention] When the hardware which performs best match processing at high speed when two or more

associative memories of the conventional type to which input data is not made as for uniform mask processing are used according to this invention can be constituted and a simple configuration is carried out, the effect that the excess and deficiency of the associative-memory capacity generated for every mask data can be prevented is done so.

[Translation done.]